CLAIMS

We claim:

1. A method for analyzing inverse scattering spectral components comprising the steps of:

determining a reflection spectrum of an object of interest;

determining a transmission spectrum of the object;

calculating $\tilde{V}_1[n]$,

where $\tilde{V}_1[n]$ is absolutely and uniformly convergence and is amenable to efficient iterative computational determination, with leading terms allowing for fast tentative identification of the object from which the spectrum is obtained.

2. The method of claim 1, wherein the for $n = 0$ and/or 1.

3. The method of claim 2, wherein the $n = 1$.

4. The method of claim 3, wherein

$$\tilde{V}_1(z) = \int_{-\infty}^{+\infty} d(2k) e^{-2ikz} \frac{2i}{k} r_k \left[1 + \frac{ik\Delta}{2} \sum_j e^{-ikz_j} V(z_j) \tilde{\psi}_k(z) \right].$$

5. A method for constructing an acceptable approximation to a true interaction comprising the step of computing an average according to the following equation:

$$\int_{z_j - \Delta_j/2}^{z_j + \Delta_j/2} dz V_1(z) = \Delta_j V(z_j)$$

adapted to obtain n approximate expressions for the $\Delta_j V(z_j)$ on a sufficiently dense set of points to using the following equation:

$$V(z) = \sum_j \delta_M(z - z_j | \sigma) V(z_j),$$

where the average take into account effects of near-field terms in the Volterra integral equation.

6. A method for analyzing inverse scattering components of a spectrum of an object of interest,

where the method utilizes equations that are absolutely and uniformly convergence and amenable efficient iterative computational determination, with leading terms allowing for fast tentative identification of the object from which the spectrum is obtained, where the method comprises the steps of:

obtaining a reflectance and/or transmission spectra of an object of interest using an incident waveform from the group consisting of an electromagnetic waveform, sonic waveform and mixtures or combinations thereof;

analyzing the spectra using an inverse scattering equations implemented on or in a processing unit (digital or analog) to derive a potential function $\tilde{V}_1[n]$ representing the object,

where an adequate potential function $\tilde{V}_1[n]$ is derivable from first few leading terms of the iterative solution of the equations.

7. The method of claim 1, wherein the first few terms comprise the first four terms.

8. The method of claim 1, wherein the first few terms comprise the first three terms.

9. The method of claim 1, wherein the first few terms comprise the first two terms.

10. An analytical instrument including an excitation source for producing an incident waveform, a detector for receiving either a transmission spectrum or a reflectance spectrum or both a transmission spectrum and a reflectance spectrum of an object or volume of interest, and a processing unit for analyzing the spectra, where the processing unit includes software encoding the inverse scattering method of Claims 1-9.

11. A sonic analytical instrument including a sonic excitation source for producing an incident sonic waveform, a detector for receiving either a sonic transmission spectrum or a sonic reflectance spectrum or both a sonic transmission spectrum and a sonic reflectance spectrum of an object or volume of interest, and a processing unit for analyzing the sonic spectra, where the processing unit includes software encoding the inverse scattering method of Claims 1-9.

12. An electromagnetic analytical instrument including an electromagnetic excitation source for

producing an incident electromagnetic waveform, a detector for receiving either an electromagnetic transmission spectrum or an electromagnetic reflectance spectrum or both an electromagnetic transmission spectrum and an electromagnetic reflectance spectrum of an object or volume of interest, and a processing unit for analyzing the electromagnetic spectra, where the processing unit includes software encoding the inverse scattering method of claims 1-9.

13. An analytical instrument including a sonic excitation source and an electromagnetic excitation source for producing an incident sonic waveform and an incident electromagnetic waveform, a detector for receiving either a sonic transmission spectrum or a sonic reflectance spectrum or both a sonic transmission spectrum and a sonic reflectance spectrum of an object or volume of interest, a detector for receiving either an electromagnetic transmission spectrum or an electromagnetic reflectance spectrum or both an electromagnetic transmission spectrum and an electromagnetic reflectance spectrum of an object or volume of interest, and a processing unit for analyzing the sonic and electromagnetic spectra, where the processing unit includes software encoding the inverse scattering method of Claims 1-9.